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Middle Carboniferous orthoconic cephalopods from the Omi Limestone Group, Central Japan

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Abstract. A Middle Carboniferous (probable late Bashkirian) fauna of orthoconic cephalopods was collected from bioclastic rudstone/grainstone in the Omi Limestone Group, Central Japan. This fauna belongs to the Taishaku-Akiyoshi-South China Faunal Province. Recognized herein are the orthocerid nautiloid *Bogoslovskya omiensis* sp. nov., the bactritids *Bactrites nagatoensis* Niko, Nishida and Kyuma, 1991 and *Bactrites* sp., and an indeterminate body chamber. This is the first reliable documentation of orthoconic cephalopods from the Omi Limestone Group.

Key words: Bactritida, Middle Carboniferous, Omi Limestone Group, Orthocerida

Introduction

Since the beginning of the Twentieth Century, some Carboniferous cephalopods have been occasionally reported by non-specialists of this group from the Omi Limestone Group, an accreted reefal buildup in Niigata Prefecture, Central Japan. The taxa cited include *Gastrioceras* sp. by Yabe (1904), *Eoasianites* cf. *orientale* (Yin) by Kato and Nakamura (1962), *Eoasianites* sp., *Gastrioceras* aff. *reticulatus* Yin, *Paralegoceras* sp. and *Reticuloceras*? sp. by Igo and Koike (1963, 1964), *Pseudorthoceras* sp. by Koizumi (1975), and *Pseudoparalegoceras*? sp. and *Stroboceras* sp. by Oyagi (2000). Unfortunately, these taxa were presented without detailed descriptions and/or illustrations, so an evaluation of their significance can not be made at this time. As the first attempt to give a reliable documentation of the Omi cephalopod fauna, the present report sheds light on the orthoconic nautiloids and bactritoids for taxonomic, biostratigraphic and paleobiogeographic purposes.

The collecting site that yielded these cephalopods is situated at the southern corner of Higashiyama Quarry, Latitude 36°59′27′′N and Longitude 137°47′8′′E, where light gray, massive bioclastic rudstone/grainstone limestone is exposed. This cephalopod-bearing limestone is Middle Carboniferous (probable late Bashkirian) in age and may be part of the reef front facies (Niko and Hasegawa, 2000). The geologic setting of the Omi Limestone Group has been described in Hasegawa *et al.* (1969, 1982), Hasegawa and Goto (1990), and Nakazawa (1997), thus it will not be repeated herein. During field work in 1997 to 1999, nearly thirty specimens identified as *Bogoslovskya omiensis* sp. nov., *Bactrites nagatoensis* Niko, Nishida and Kyuma, *Bactrites* sp., along with an indeterminate body chamber were collected in cooperation with Mr. Toshiaki Kamiya. This association of genera is characteristic of the Taishaku-Akiyoshi-South China Province (Niko, 2000).

All specimens studied are reposited in the University Museum of the University of Tokyo (UMUT).

Systematic paleontology

Subclass Nautiloidea Agassiz, 1847
Order Orthocerida Kuhn, 1940
Superfamily Orthoceratoidea M'Coy, 1844
Family Orthoceratidae M'Coy, 1844
Subfamily Michelinoceratinae Flower, 1945
Genus ***Bogoslovskya*** Zhuravleva, 1978

Type species. — *Bogoslovskya perspicua* Zhuravleva, 1978.

Bogoslovskya omiensis sp. nov.

Figure 1.1-1.3, 1.5-1.9

Diagnosis.—Species of *Bogoslovskya* with 6°-7° angle of shell expansion, approximately 0.9 in form ratio of shell, transverse surface lirae; form ratio of camera 1.8-3.1; siphuncle strongly eccentric, its position ratio 0.13.

Description.—Orthocones with 6°-7° angle of shell expansion and laterally compressed cross section yielding lateral/dorsoventral diameter ratio (form ratio of shell) of approximately 0.9; largest specimen (paratype, UMUT PM 27892) of phragmocone reaches 16.5 mm in dorsoventral di-

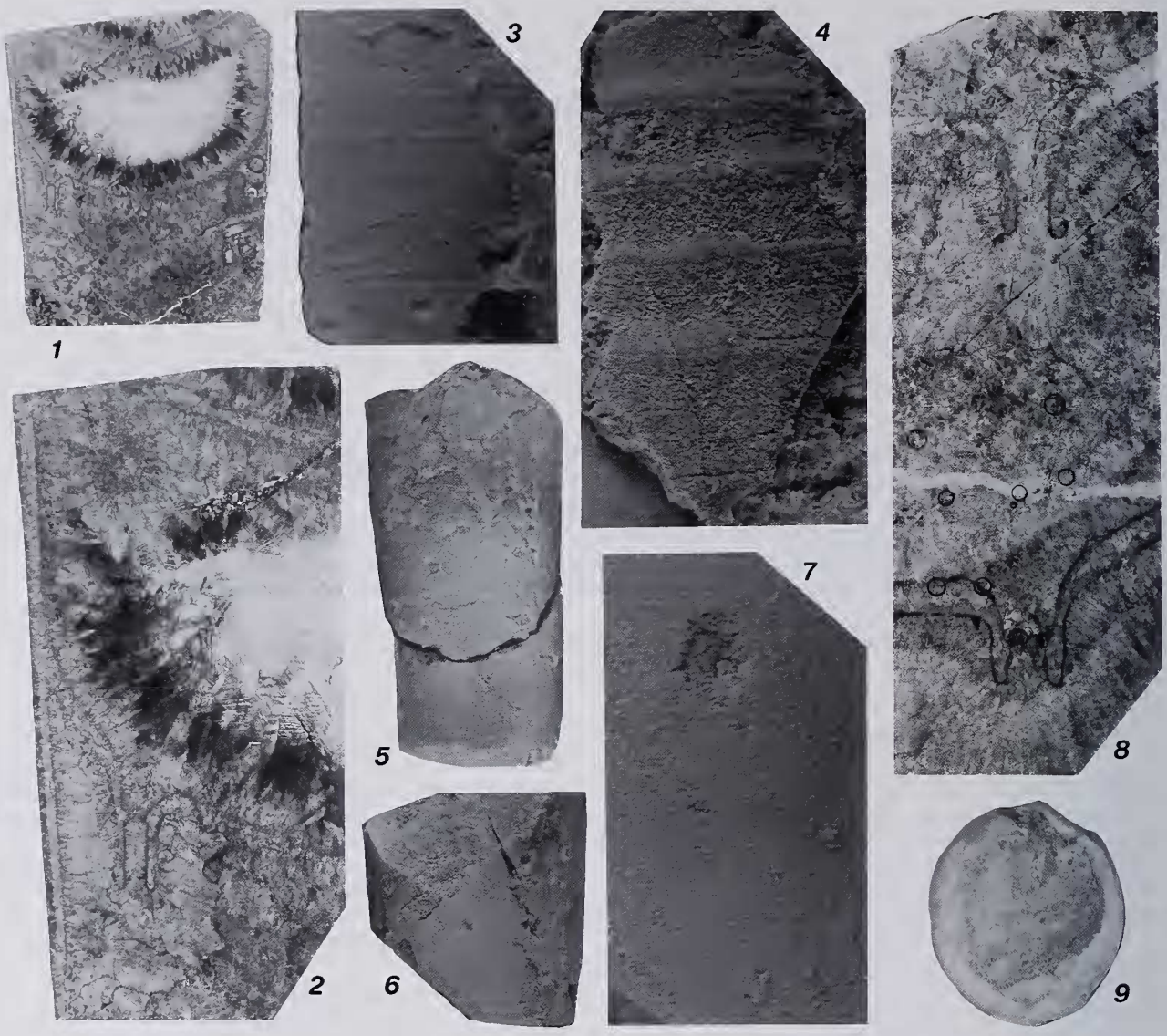
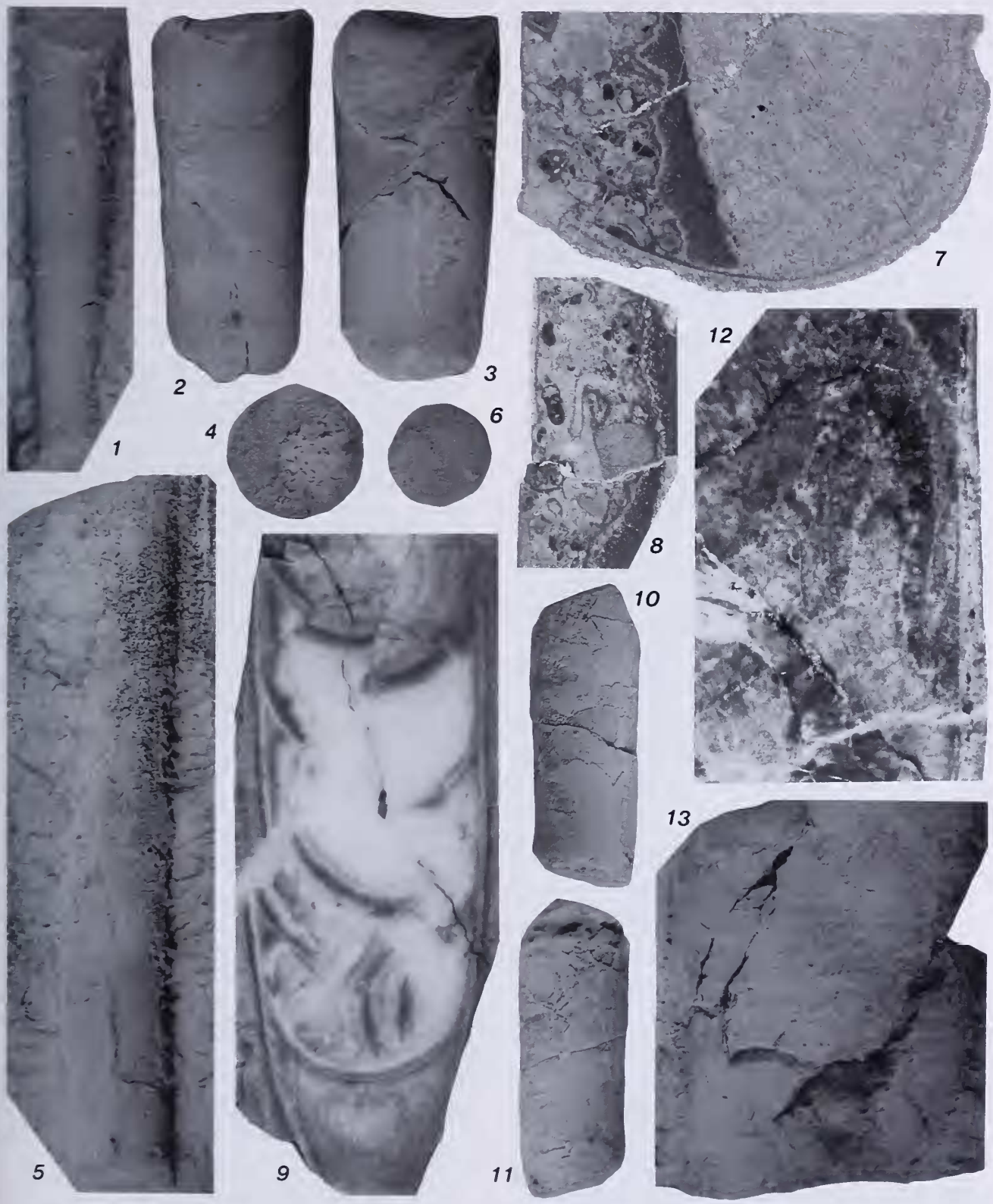


Figure 1. **1-3**, **5-9**. *Bogoslovskya omiensis* sp. nov. **1-3**. Holotype, UMUT PM 27890; **1**, dorsoventral thin section, ×5; **2**, details of apical siphuncle, ×14; **3**, details of surface ornamentation of apical shell, ×10. **5**, **8**. Paratype, UMUT PM 27891; **5**, side view of anti-siphuncular side, ×2; **8**, details of adoral siphuncle, thin longitudinal (but not dorsoventral) section, × 14. **6**, **7**, **9**. Paratype, UMUT PM 27892; **6**, side view, siphuncular side on right(?),× 2; **7**, details of surface ornamentation of adoral shell, ×10; **9**, polished section near adoral end, siphuncular side down(?), slightly deformed, × 2. **4**. Indeterminate body chamber, UMUT PM 27918, details of surface ornamentation, ×5.

ameter. Surface ornamentation of apical shell (represented by holotype, up to 7.9 mm in dorsoventral diameter) consists of subdued transverse lirae with somewhat unequal size and intervals, then it shifts to closely spaced, fine, transverse lirae on adoral shell (ditto paratypes). Sutures not observed, but obvious obliquity not observed in dorsoventral section. Septa moderately deep; cameral length relatively short for genus, 4.1 mm in length, with maximum dorsoventral diame-

➡ **Figure 2.** 1-5. *Bactrites nagatoensis* Niko, Nishida and Kyuma, 1991. **1**. UMUT PM 27897, dorsal view, ×3. **2-4**. UMUT PM 27895; **2**, ventral view, ×3; **3**, dorsal view, ×3; **4**, apical view, venter down, ×3. **5**. UMUT PM 27896, dorsal view, ×1.5. **6-12**. *Bactrites* sp. **6-8**, **10**, **11**. UMUT PM 27916; **6**, apical view, venter down, ×3; **7**, dorsoventral thin section, venter on left, ×14; **8**, details of apical septal neck, venter on left, ×14; **10**, ventral view, ×3; **11**, dorsal view, ×3. **9**, **12**. UMUT PM 27917; **9**, longitudinal (near dorsoventral) polished section, venter on right, ×2; **12**, details of adoral septal neck, longitudinal (near dorsoventral) thin section, venter on right, ×14. **13**. Indeterminate body chamber, UMUT PM 27918, side view, ×1.5.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ter/length ratio (form ratio of camera) 1.8 in apical shell; this ratio increases to 2.5–3.1 in adoral shell. Siphuncular position strongly eccentric and submarginal, minimum distance of central axis of siphuncle from shell surface per corresponding dorsoventral shell diameter (siphuncular position ratio) is 0.13 in holotype. Septal necks long for family; they are orthochoanitic and cylindrical in apical shell, then shifts gently tapering and funnel-shaped orthochoanitic forms in adoral shell; length of septal necks on anti-siphuncular (dorsal?) side ranges from 1.03 mm to 1.28 mm; siphuncular diameters 0.42–0.70 mm at tips of septal neck, where septal foramen is 0.23–0.42 mm in diameter, giving a diameter of septal neck/corresponding dorsoventral shell diameter ratio of approximately 0.06. Annulus of weak auxiliary deposits recognized in septal foramina. Connecting ring not preserved; no cameral deposits detected.

Discussion.—Among the three previously known Upper Paleozoic species of this genus (see Niko *et al.*, 1995, 1997, Niko and Ozawa, 1997), *Bogoslovskya omiensis* sp. nov. bears the greatest similarity to *B. akiyoshiensis* Niko, Nishida and Kyuma (1995, figs. 1.1–1.14) from the Middle Carboniferous (Moscovian) in the Akiyoshi Limestone, Southwest Japan. Although the gross shell shape and the surface ornamentation suggest the close phylogenetic relationship of the both species, the main character of *Bogoslovskya omiensis* that separates it from *B. akiyoshiensis* is the more eccentric siphuncular position, with a siphuncular position ratio of 0.13 versus 0.19 for the corresponding shell diameter in *B. akiyoshiensis*.

Etymology.—The specific name is derived from the Omi Limestone Group, in which this species occurs.

Material examined.—The holotype, UMUT PM 27890, is an incomplete phragmocone 9.3 mm in length. The following two paratypes of the incomplete phragmocones are assigned: UMUT PM 27891, 27.0 mm in length, and UMUT PM 27892, 12.8 mm in length. They represent more adoral shells than the holotype. In addition, two fragmentary specimens, UMUT PM 27893, 27895 are referred to this species with reservation.

Subclass Bactritoidea Shimanskiy, 1951
Order Bactritida Shimanskiy, 1951
Family Bactritidae Hyatt, 1884
Genus ***Bactrites*** Sandberger, 1843

Type species.—*Bactrites subconicus* Sandberger, 1843.

Bactrites nagatoensis Niko, Nishida and Kyuma, 1991

Figure 2.1–2.5

Bactrites nagatoensis Niko, Nishida and Kyuma, 1991, p. 715, figs. 2.1–2.10, 3.1–3.5.

Bactrites cf. *nagatoensis* Niko, Nishida and Kyuma. Niko *et al.*, 1997, p. 106, figs. 3.9, 4.8.

Discussion.—Twenty-one bactritid specimens of the orthoconic phragmocones with an angle of adoral shell expansion of approximately 5°–6° were collected from Higashiyama Quarry. The shell diameters range from 2.3 mm (UMUT PM 27907) to 25.1 mm (UMUT PM 27915). They have the shell morphology typical of the holotype, which is from the Moscovian (Middle Carboniferous) of the Akiyoshi Limestone, with rapid shell expansion for *Bactrites* and a single dorsal carina throughout the known phragmocone. A form possibly conspecific with this species also occurs in the Moscovian limestone of the Dala (Huanglong) Formation, Guizhou Province, South China (Niko *et al.*, 1997). Comparisons of *Bactrites nagatoensis* to three Laurentian species (*B. finisensis* Mapes, 1979, pl. 23, figs. 4–6, *B. mexicanus* Miller, 1944, pl. 20, figs. 8, 9, pl. 21, figs. 4–6, and *B. peytonensis* Mapes, 1979, pl. 8, figs. 4–14, pl. 9, figs. 2, 3, 6–8, 12, 13, 15, 17–19, pl. 14, figs. 7, 8, 10) having a dorsal carina are referable in Niko *et al.* (1991, p. 715).

Material examined.—UMUT PM 27895–27915.

Bactrites sp.

Figure 2.6–2.12

Description.—Orthocones with gradual shell expansion indicating near 2° in angle; cross section of shell circular; largest specimen (UMUT PM 27917) attains approximately 19 mm (slightly deformed) in diameter at adoral phragmocone. Surface ornamentation and carina absent, wrinkled layer not observed. Except for ventral lobe, sutures are nearly straight and slightly oblique at 6°–15° to rectangular direction of shell axis, toward aperture on dorsum. Septal curvature moderate; cameral length moderate with approximately 1.6 in diameter/length ratio. Siphuncular position ventral margin; ventral septa attached to shell wall; septal necks orthochoanitic, relatively long for genus; dorsal septal necks 0.82–1.26 mm in length; diameter of septal foramen/corresponding shell diameter is approximately 0.07; connecting ring not preserved. No cameral and endosiphuncular deposits detected.

Discussion.—This species is known from the two fragmentary phragmocones, but is easily separable from associated *Bactrites nagatoensis* by the slenderer shell and the lacking a dorsal carina. The features approach those of *Bactrites carbonarius* Smith (1903, pl. 6, figs. 9–11), *B. fayettevillensis* Mapes (1979, pl. 9, figs. 9–11, pl. 10, figs. 6–8, pl. 13, figs. 1, 7, 8, 11, 12, 14–16, pl. 14, fig. 9, pl. 15, figs. 1, 2, 6, 7, 12–14), *B. longocameratus* Shimanskiy (1949, fig. 1), *B. milleri* Mapes (1979, pl. 10, fig. 10, pl. 12, figs. 4, 8–12), *B. quadrilineatus* Girty (1909, pl. 6, figs. 1, 1a, 1b, 2–4, 4a), *B. smithianus* Girty (1909, pl. 6, fig. 5, 6?), and *B.* sp. (Niko *et al.*, 1991, figs. 3.6–3.9). Due to the poor preservation of the Omi specimens and the relatively simple morphology of this group for *Bactrites*, specific comparisons cannot be made at this time.

Material examined.—UMUT PM 27916, 27917.

Subclass, Order, Superfamily, Family, Genus, and Species uncertain

body chamber

Figures 1.4, 2.13

Discussion.—A fragmentary body chamber of an orthoconic shell, 67.5 mm in length and 39 mm+ (deformed)

in diameter, is available for this study. Although its surface ornamentation consisting of weak annulations and lirae shows an affinity to the mature modification of some bactritids including *Bactrites peytonensis* Mapes and *Bactrites*? sp. morphotype 13 (Mapes, 1979, pl. 2, figs. 14–16), lack of knowledge of the siphuncular structure and position precludes a positive identification even to be subclass level. Similar ornamentation is also known to occur in the Carboniferous orthocerids, such as *Brachycycloceras* (Miller *et al.*, 1933), *Cryptocycloceras* (Shimansky, 1968), *Cycloceras* (M'Coy, 1844), and *Reticycloceras* (Gordon, 1960).

Material examined.—UMUT PM 27918.

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